SMOKE AND MIRRORS: THE UNINTENDED PUBLIC SAFETY EFFECTS OF MARIJUANA LEGALIZATION

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Abstract:

Existing research on the indirect societal impacts of marijuana legalization is piecemeal and tends to under-emphasize the strains placed on the public safety apparatus as a result of increased access and availability to a federally unregulated substance. To examine the effect geographic proximity to marijuana dispensaries has on Colorado's state-wide crime rates, this paper conducts clustering analyses on public safety data from the years following Colorado's legalization policy enacted in 2012. The analyses targeted reported crime from 2013-2018 throughout Colorado to determine the predictive power of geographic inputs for crimes specifically associated with the growing legal marijuana industry. There is an historic over-emphasis placed on the primary health effects resulting from marijuana legalization with minimal insight to how secondary criminal activity, directly linked to a growing legal market, impacts communities differently. The results offer strong support for the hypothesis that, in the absence of strategic planning addressing the sociocultural vulnerabilities of a community, marijuana legalization policy heightens criminal activity proximal to the densest areas of legal marijuana dispensaries where availability and accessibility are highest.

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1. A National Conversation Approached Through Fractured Policy Choices

Amidst an ongoing and devastating drug epidemic nationwide, policy implications for licit and illicit drug use remain an important platform on which public health messaging takes shape and prosecutorial powers are determined. The available research on the psychosocial, physical, cognitive, and community level impacts of substances like alcohol and opiates has been well-documented and remains a focus of prevention educators and the larger medical community. This same level of research and insight into the impacts of marijuana, however, remains sparse and controversial at best; limiting the potential for wholistic and evidence-based policy structures for states pursuing legalization. Although there is growing research dedicated to addressing the cognitive and physical side effects of recreational marijuana, there remains little focus on community level disruptions relative to legalized businesses affording ease of access and increased availability. Prior to legalization, law enforcement entities follow federal guidelines related to use and possession laws and prosecute accordingly. However, with state legalization superseding federal regulations, inadequate strategic planning initiatives prior to formalized state policy creates unintended strains on a community's public safety apparatus. By under-preparing for anticipated use and possession increases, law enforcement enclaves are ill-equipped to handle the unintended secondary impacts of legalization within a larger sociocultural crime landscape.

The complexity of marijuana legalization goes beyond decriminalizing use and possession regulations and must extend to understanding the stratification of community demographics that ultimately inform how legalization will be embraced. Legal use and sale do not eliminate blight or addiction within communities but can instead widen those

divides and epidemics even further. Legality of the substance does not equalize individuals' ability to buy the same quantity and quality of recreational marijuana. As a result, being able to legally purchase marijuana does not necessarily change acquisition methods within a community. Socioeconomic inequalities and age factors within a legal environment worsen the burden placed on law enforcement because the policy change does not address the underlying risk factors informing substance use and possession. Adolescents will still turn to diverted use from legal purchasers and lower socioeconomic populations, or those with a criminal background precluding them from legal purchase, will still likely use illegal methods for obtaining marijuana. Legalization does not introduce inherently new barriers to access for a given population. Instead, the perception off harm associated with use at any age dramatically decreases and the opportunity for experimentation with legal ease of access dangerously increases.

Colorado serves as a trailblazer in the marijuana legalization arena, for better or for worse. Only a year after the state legalized in 2012, the Governor himself lamented the lack of aforethought given to strategic implementation of the policy change and admitted, in retrospect, legalization was the wrong choice for the state. Worsening health conditions and emergency room admissions, especially among youth, saw an increase in the years following legalization, placing an added stressor on the medical community. In addition, Colorado's crime landscape saw waves of direct and indirect crime resulting from a burgeoning marijuana industry throughout the state. The physical locations of legal dispensaries add a layer of geographic vulnerability for municipalities' crime rates because they become targets for burglary and low-level street crime. Colorado's Department of Public Safety began collecting preliminary data related to crime in and

around the state's active marijuana industry in 2013. However, formalized research on the geographic impact of newly zoned and opened legal marijuana dispensaries on the expansion of crime rates is still lacking from the larger policy conversation. This paper therefore aims to identify clustered crime rates relative to legal marijuana dispensaries by analyzing the predictive power of the geographic inputs of Colorado's Department of Public Safety's most recent marijuana industry crime data. This paper explores the predictive power of geography and posits that, in the absence of strategic planning addressing the sociocultural vulnerabilities of a community, marijuana legalization policy heightens criminal activity proximal to the densest areas of legal marijuana dispensaries where availability and accessibility are highest. The research to follow additionally aims to begin a conversation on the importance of strategic planning prior to legalization and suggests the need for further research to better understand the layered complexity of legalization.

2. The Known Effects of Marijuana

2.1 Physical and Cognitive Ramifications of Unregulated Recreational Marijuana

At a fundamental level, the dangers of legalizing marijuana have solid pharmaceutical and scientific concerns. Unlike licit medications for palliative care, marijuana "is not a single-agent compound" but rather a combination of more than 100 different chemicals, the interaction of which are still not fully understood.[1] While certain individual components of marijuana have been removed, purified, and tested for medicinal use, the larger marijuana industry remains free from federal control and

[1] Wilkinson, Samuel T., et al. "Marijuana Legalization: Impact on Physicians and Public Health." *Annual Review of Medicine*, vol. 67, no. 1, 2016, pp. 453–466., doi:10.1146/annurev-med-050214-013454.

oversight. Unlike the required and stringent approval processes for other medications by the US Food and Drug Administration (FDA), marijuana does not pass through these same protocols and therefore remains unregulated. Industry manufacturers are therefore not required to adhere to specific chemical compound combinations and can deliver the product in a variety of ways (i.e. vaping, edibles, joints, etc.), none of which have passed through necessary clinical trials to determine recreational safety or medicinal efficacy. In fact, recent data from Colorado's university emergency room indicates that following legalization admittance to the ER for severe burns related to marijuana use noticeably increased, mainly related to the increased trend of "dabbing" where the marijuana is smoked in oil rather than leaf form.

In 2014, 31 patients were admitted for marijuana-related burns; some cases involved more than 70% of the body's surface and 21 of the patients required skin grafting to remedy the damage.[2] Similar data demonstrate that diversification of use has complicated the industry's regulatory policies even further. Increased cases of emergency room admittance related to marijuana-associated illnesses have been suggested to be linked to the new trend of marijuana edibles. Users tend to take larger quantities in edible form over shorter periods of time, however the chemical potency of the drug once in the system has a delayed reaction when ingested rather than smoked and users fail to moderate their intake based on absorption rates. This trend was evidenced in emergency room visits following Colorado's legalization where ED's went from seeing 1-2 patients a week for marijuana intoxication to 10-15 a week.[3] Such an increase not only indicates

[2] Monte, Andrew A., et al. "The Implications of Marijuana Legalization in Colorado." *Jama*, vol. 313, no. 3, 2015, p. 241., doi:10.1001/jama.2014.17057.
[3] Monte, Andrew A., et al. "The Implications of Marijuana Legalization in Colorado."

the lack of education on the physiological effects of marijuana but it also suggests that overdose-like consequences can result from improper marijuana use.

2.2 The Relationship Between Perceptions of Harm and Use Rates

Changes in use patterns and paraphernalia options have also now made marijuana more accessible and more easily concealed by underage users. Legalization has only increased accessibility and acceptability of the drug, and created new avenues for underage users to obtain the substance through the legal purchase by adults.[4] In a recent cross-sectional study done among Colorado adolescents enrolled in outpatient substance-use treatment programs, roughly 50% reported using diverted marijuana—given by an older adult—rather than obtaining it themselves directly.[5] This suggests that youth perceptions of parental and peer disapproval appear to decrease in the face of legalization and that age of initiation of use is likely to decrease as availability and ease of access through pseudo-legal means increase. These indicators for future adolescent use are supported by the federally developed Monitoring the Future study, which has shown "a clear inverse relationship between risk perception and marijuana use among adolescents": with lowering perceptions of risk comes higher rates of use at younger ages.[6] Approval through policy change and perceived acceptance from adults affects youth perception of harm of marijuana, which sets a dangerous precedent for generational use in a legalized environment. It has additionally been reported that the known cognitive, psychological, and physical side effects of marijuana use are heightened in younger populations as brains and regulatory systems remain undeveloped and therefore more susceptible to

[4] Wilkinson, Samuel T., et al. "Marijuana Legalization: Impact on Physicians and Public Health."
[5] Monte, Andrew A., et al.
[6] Khatapoush, Shereen, and Denise Hallfors. "'Sending the Wrong Message': Did Medical Marijuana Legalization in California Change Attitudes about and Use of Marijuana?" *Journal of Drug Issues*, vol. 34, no. 4, 2004, pp. 751–770., doi:10.1177/002204260403400402.

damage from foreign substances. Schweinsburg et al. explored marijuana's effect on adolescent cognition and concluded that "adolescents demonstrate persisting deficits related to heavy marijuana use for at least 6 weeks following discontinuation, particularly in the domains of learning memory, and working memory."[7] If developmental processing is interrupted with the introduction of marijuana to our younger populations, then legalization would likely be adding an unintended but unsustainable strain to the current medical systems within communities as a result of documented increases in hospital visits resulting from marijuana-related issues. Contrarians argue that correlational evidence in cognitive declines related to marijuana cannot be solely linked to a causal relationship nor can they be blamed on legalized policy. However, establishing a direct causal relationship is not and should not necessarily be the goal of ongoing study. Drug use of any kind is not an isolated effect of individual decision-making. Rather, the patterns of initiation and continued use are informed by a variety of both internal and external factors cultivated within a larger social network that either encourages risk-taking behavior or works to create an environment more supportive of establishing protective factors. Policy change is therefore a component of a larger problem that has the power to alter the drug landscape for decades to come.

2.3 Poorly Supported Policy Weakens the Public Safety Apparatus

With a growing research catalogue focused on the cognitive and physical effects of marijuana, few analyses have attempted to substantively link societal, health, and public safety changes more directly to the inherent messaging behind legalized marijuana

[7] Schweinsburg AD, Brown SA, Tapert SF. The influence of marijuana use on neurocognitive functioning in adolescents. Curr Drug Abuse Rev. 2008;1:99–111.

policy and the increased accessibility to the substance. Although there was initial concern expressed by Colorado's state government, popular decision was still ratified, subsequently enforcing social acceptance of use at the policy level. Quantitative and qualitative evidence supports a societal compound effect theory by offering that "cannabis use in adolescence and early adulthood is associated with poor social outcomes, including unemployment, lower income, and lower levels of life and relationship satisfaction."[8] A major concern regarding the majority of current research on marijuana use and its epidemiology is it has been conducted in environments where marijuana remains illegal, disallowing for comparative analyses to better examine the change in relationship between policy, attitude, and use patterns in a post-policy environment.[9] This restricted research base limits the generalizability of previously studied "patterns of marijuana use, associations with other substances, patterns of development of marijuana disorders, and associations with other psychopathology…[to] and environment where marijuana use has greater social acceptance, is marketed and available in different forms, and where the marijuana itself may have substantially higher THC contents than marijuana previously consumed".[10] Christian Hopfer posits that, because of the general uncertainty surrounding the impact of marijuana on the psychosocial, physiological, and cognitive functions of adolescents versus adults, a legalized environment encourages experimentation over education. In the absence of necessary support structures to deal with the unintended and otherwise ignored consequences of legalized use, communities will remain ill-equipped to prepare for or

[8] Wilkinson, Samuel T., et al. "Marijuana Legalization: Impact on Physicians and Public Health."
[9] Hopfer, Christian. "Implications of Marijuana Legalization for Adolescent Substance Use." *Substance Abuse*, vol. 35, no. 4, 2014, pp. 331–335., doi:10.1080/08897077.2014.943386.
[10] *Ibid.*

adapt to an institutionalized approval of drug use. Hopfer offers that the self-perpetuating claims of medicinal benefits have incorrectly transferred a lower perception of harm to marijuana's recreational formulations. This perception was only emboldened after President Obama's Ogden Memo of 2009 where use of the substance for palliative care set a federal precedent. As a result, there has remained little emphasis on the study of the long-term effects of marijuana. This poses great concern for understanding how the adolescent population will be effected within a legal adult environment where accessibility and ease of use greatly increase.[11] Prevention and education efforts will be less effective at staving off risk-taking behaviors among youth and young adults because they will be forced to operate in an environment where public opinion is backed by political authority and formalized policy in the absence of structured evidence-based guidelines.

Despite the inherent state freedoms to amend constitutions, policy in direct opposition to current federal guidelines means state governments remain accountable for federal law violations. Regardless of initial attempts to campaign against decriminalization by several Colorado officials, Amendment 64 the "Regulate Marijuana Like Alcohol Act of 2012" launched the state into one of the greatest social experiments of recent times.[12] Legalization could therefore mean the aiding and abetting of criminal acts by state governments in the process of assisting with the licensure of marijuana establishments in a now state-level legalized environment.[13] However, proponents cited the prohibition argument to suggest that with marijuana legalization state and local

[11] Hopfer, Christian. "Implications of Marijuana Legalization for Adolescent Substance Use."
[12] Blake, David, and Jack Finlaw. Marijuana Legalization in Colorado: Learned Lessons. Harvard Law & Policy Review, 2014, Marijuana Legalization in Colorado: Learned Lessons.
[13] Blake, David, and Jack Finlaw. Marijuana Legalization in Colorado: Learned Lessons.

budgets would have added revenue, regulation of use by age would limit initiation of use and continued use among youth, and barriers to an intrusive government could be created thereby increasing the social freedoms deemed a natural born right by citizens.[14] While compelling arguments, they lacked substantive federal or state-level guidelines to frame implementation to preempt the ratification of Amendment 64. As a result, increased tax revenue was limited because access to federal banking channels proved difficult for marijuana industries while federal policy still criminalized the sale and use of recreational marijuana.[15] Furthermore, legalization highlighted the blatant lack of solidified regulatory processes and in fact undermined the ability of local and state-level law enforcement entities to enforce public safety priorities related to marijuana use and sale. Prior to ratification of Amendment 64 there was a woeful lack of definition of "open and public consumption, drugged driving, and the home-grow gray market" as they related to legal recreational marijuana.[16] As a result, Colorado was faced with enforcement and systemic barriers to "licensing, background checks for owners and employees of marijuana-related businesses, employee rights, addiction in the context of family law, enforcement of marijuana contracts, cultivation-practices, potency limits, labeling, advertising, and online sales."[17] Environments in which poor regulatory forethought exists, coupled with minimal knowledge of the detrimental effects of marijuana use, weaken the sociopolitical system and limit the resources available to adequately support policy change.

[14] *Ibid.*
[15] *Ibid.*
[16] *Ibid.*
[17] *Ibid.*

Legalization proponents argue that "policy change will force more stringent regulation and safer use of marijuana, more efficient use of law enforcement resources, and possibly even a decline in the prevalence of marijuana use among adolescents and the use of 'harder' drugs."[18] However, Colorado's post-legalization data have suggested that institutionalizing marijuana use at a policy level actually limits the capacity of law enforcement units and increases the potential long-term harmfulness of an otherwise unregulated substance on individuals and communities. While legalization means recreational use and possession are legal, there still needs to be thresholds in place that determine public use laws, possession limits, and drugged driving regulations. The lack of structured enforcement protocol and added support to public safety apparatuses weakens police districts' ability to effectively police diversifying crime in communities.

The continued lack of research examining how policy changes the physical drug landscape and makes communities more vulnerable to increased crime and use rates severely limits the ability of decision-makers and law enforcement professionals to efficiently and effectively support and protect the communities within which they serve. Without understanding and working to accommodate each layer associated with substance use of any kind, legalization will likely destabilize the drug and crime landscapes of communities. The implications of legalization on societal, health, and public safety outcomes are evident, but current research remains disjointed and poorly synthesizes an analysis on how the attitude and behavioral changes that result from a major policy shift inform these individual and population level changes.

3. Colorado's Public Safety Data

[18] Blake, David, and Jack Finlaw. Marijuana Legalization in Colorado: Learned Lessons.

This paper accessed Colorado's open data portal to obtain a dataset containing 13 variables collected over a five-year period from 2013 to 2018 from the Department of Public Safety. The data provides geographic information relative to reported crime broken down by marijuana industry or non-industry incidents. The data was collected beginning shortly after Colorado's 2012 legalization and continued through the end of 2018, making the empirical measurements most relevant for the focus of this research. The dataset was cleaned and recoded in Microsoft Excel prior to importing to IBM's SPSS Modeler where it was analyzed through clustering techniques to determine the predictive power of geographic indicators for marijuana industry related crime. The original data fields pertained to case numbers, crime categories, neighborhood identifiers, police districts and precincts responding to crime, report dates, first and last occurrence dates, and latitude and longitude coordinates of the reported crime.

3.1 Variable Measurements, Manipulations, & Parameters

SPSS interacts with the data through "nodes" that are connected on the interface to form a communication channel for data manipulation steps prior to and during modeling. Measurement selections are assigned through the type nodes, which sets the parameters for modeling and graphing. SPSS automatically reads in the values provided on the dataset and assigns a variable measurement accordingly, however the measurements need to be assigned based on the purpose of the variable in the context of the larger dataset. Prior to any modeling, these measurements need to be set to ensure the variables can be accurately represented during and after modeling.

In order to isolate key variables and minimize repetitive fields, the following variables were filtered out in SPSS: incident identification number, first occurrence date,

last occurrence date, latitude and longitude coordinates, and offense type code. Incident identification numbers did not add valuable information to the dataset for the purposes of understanding clusters of crime. The coordinate fields were not coded in a spatially compatible file format and were therefore difficult to manipulate. For the purposes of identifying specific geographic neighborhood and police precinct patterns in marijuana related crime, substituting the non-geocoded coordinate variables for the nominal neighborhood and police district variables allowed for more specificity and immediacy in modeling and understanding subsequent results. The first and last occurrence dates were not as valuable as understanding patterns within the five-year spread of the data that was available within the report date field. Lastly, offense codes did not provide the immediate descriptive information for modeling purposes as did the offense category.

The remaining 7 variables were reassigned measurements to better represent their qualitative context within the dataset. For instance, the police district field defaults to a continuous variable between values 1-10. This means that, when graphed or statistically analyzed, decimal places are created for the value when they do not functionally exist. In other words, there is no police district 1.2, only police district 1 or police district 2. The police district variable was therefore changed to a nominal measurement, which would not alter its state and each individual police district could be read individually rather than on a continuum. The general report date field kept was originally coded in the DD/MM/YY format, complicating its use for modeling. The date field was first transformed in Excel by filtering each individual DD/MM/YY data point and recoding to a YYYY format. Once loaded to SPSS, the report date variable was transformed to a continuous variable ranging between years 2013 and 2018. The only flagged variable in

this dataset was marijuana industry related crime as it contains only two values: industry or non-industry descriptors. Assigning a flagged variable measurement allows marijuana industry crime to act as a binary variable during analyses.

Table 1 below shows how the 7 remaining fields were assigned variable measurements prior to modeling. The combination of measurements allowed for a diversification and specification of modeling options.

Table 1: Colorado Public Safety Data: Modeling Variable Measurements

Variable	Measurement
Report Date	Continuous
Police District ID	Nominal
Police Precinct Number	Nominal
Offense Type Category	Nominal
Offense Subtype Category	Nominal
Marijuana Related Industry Crime	Flag
Neighborhood Name	Nominal

3.2 Anomaly Testing and Two-Step Clustering Methodologies

The first step of analysis was anomaly testing, which allows unusual cases from the larger dataset to be separated from identified general patterns. Understanding the outliers in any dataset is important for outlining the need for future research focuses. Anomaly testing also serves as a general clustering method that can be compared to the specific targeted results from two-step clustering analyses. Although anomaly testing is a quick method for locating outliers in a dataset, it does not account for an identified dependent variable like a typical cluster analysis. Instead, anomaly testing takes the dataset as a whole and identifies noticeable patterns and then highlights unusual cases within those patterns. For this reason, coupling anomaly testing with additional clustering

models is a unique way for supplementing predictor importance under a targeted clustering analysis.

While there are several clustering techniques, two-step clustering is the most accommodating for different variable measurements. Two-step clustering can create groupings regardless of the variance in categorical, nominal, or continuous variable inputs. For this reason, two-step clustering made the most sense for the Colorado data given the diversity of variable measurements and the restrictions that diversity places on parameter setting for modeling options. Additionally, two-step clustering automatically selects the best number of clusters, measures the quality of the model given the data inputs and resulting clusters, and ranks the inputs based on predictor importance relative to the target (dependent) variable selected in the type node.

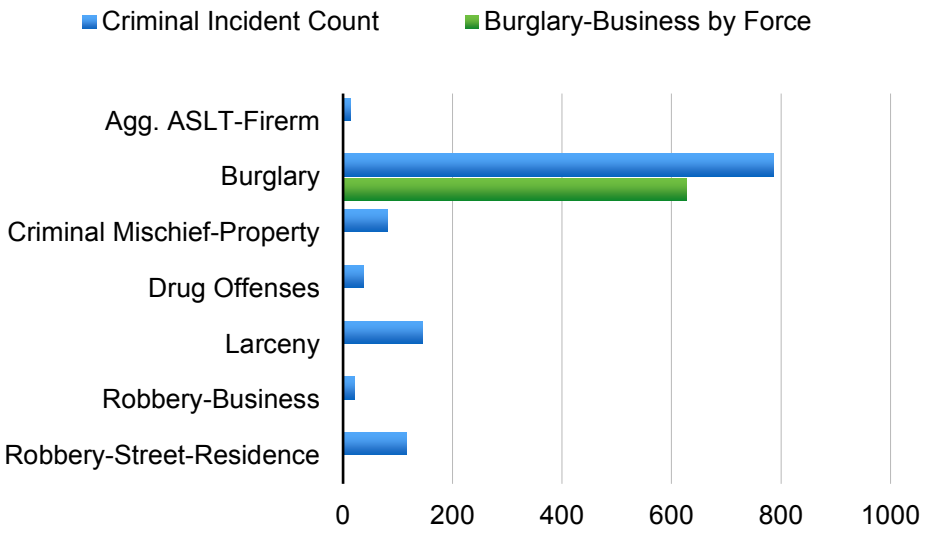
While anomaly testing produces Marco-level clustering, two-step clustering methods produce more micro-level groupings based on a set target variable and ranked predictor inputs. Using both methods in tandem has two benefits. First, the results of anomaly testing can help account for researcher bias in the two-step clustering where variables are specifically included or excluded from the model. Second, the generalities of anomaly testing can serve as comparative results to the more specific modeling done with a target variable. In other words, attempting to identify clustering without prefacing the model with a pattern of interest could help further elucidate the two-step clustering results.

4. Policing Policy: The Weakening Public Safety Apparatus

4.1 Secondary Crime and the Marijuana Industry

To gauge baseline correlations in the data, the statistics node was first used to examine the relationship between offense type and police district locations. The offense code variable was examined looking at the most frequently occurring code relative to the total dataset in order to determine which crime, if any, is proportionally higher over the five-year span under analysis. The most frequently occurring offense code was 2203, which corresponds to burglaries in the original dataset. In fact, according to the original data, all 632 cases assigned to offense code 2203 were related to thefts/burglaries within the marijuana industry; the majority of which were sub-categorized as burglaries by force. A correlation regression was then run using the statistics node to examine the relationship between offense code and police district locations. Revealing a Pearson Correlation of -0.100, it was determined that there is a strong correlation between offense code and district, suggesting that Colorado crime is in fact informed by geography. Visualizing this statistical breakdown, Graph 1 below demonstrates the dispersal of the most reported crime from 2013-2018. As evidenced below, burglary far exceeds all other top-level crime categories during this time period. Although not all categories are represented, Graph 1 serves to highlight the stark differences in crime rates for burglary compared to the remaining top ranked high frequency crimes throughout Colorado.

Graph 1: Colorado Highest Reported Crime Categories, 2013-2018



Graph 1: The blue bars indicate total crime counts for that category in Colorado between 2013 and 2018. The green bar has been added as a comparative example of the sub-category breakdown of burglary crimes. Almost 80% of all burglaries were of business where force was used. As mentioned, all 632 cases represented by the green bar were within the marijuana industry.

Interestingly, drug offenses made up less than 3% of all crime between 2013 and 2018, which could speak to a larger policy issue at play within a legalized community. Prosecution of crimes related to marijuana use and possession have become increasingly more difficult in the face of legal policy. Policy changes were not implemented alongside a collaborative law enforcement framework making prosecution of direct use and possession crimes in the face of diversifying chemical compounds and paraphernalia challenging at best. Graph 1 does suggest that patterns of indirect crime resulting from a newly formed legal marijuana industry are a vulnerability for the community and public safety apparatus. This pattern sets the stage for identifying how geography impacts marijuana related crime and highlighting how policy implemented without added social supports strains already scarce law enforcement resources as a result of peripheral crime related to a growing marijuana industry.

4.2 Geography as a Predictor of Marijuana Related Crime

Anomaly testing generated two peer group profiles representative of general patterns within the data, with equal weight given to all variable inputs. Peer Group 1 consisted of 584 records with 11 anomalies. The profile of Peer Group 1 revealed 46% of reported crime was burglary of business by force within police district 2 between 2015 and 2016. Table 2 explains the breakdown of the 11 total anomalies detected within Peer Group 1. The contribution column represents which variable fields are most frequently associated with the outliers, the count column indicates how many times the given variable is associated with an outlier, and the average index column represents the ratio of the group deviation to its average over the cluster to which it is assigned. It should be noted that all 11 anomalies were associated with outlier offenses whereas the remaining variables are associated with less than 11 anomalous cases.

Table 2: Peer Group 1 Anomalies:

Contribution	Count*	Average Index**
Police District ID	10	0.241
Incident ID	5	0.483
Offense Type ID	11	0.197
Offense Code	6	0.483
Report Date	1	0.071

*Values indicate how many of the anomalies were associated with a given variable. For example, 10 of the 11 had anomalous police districts while only 1 of the 11 had an anomalous report date.
**Values less than 1 are not considered strong enough deviations to be representative of severe outlier cases.

Peer Group 2 found only 2 anomalies amidst 787 evaluated records. The profile determined the crime in police district 3 around 2015 was the highest reported and of that crime 45% was once again burglary of businesses by force, a similar pattern to Peer Group 1. In fact, both police districts 1 and 2 encompass the Denver metropolitan area, which suggests a general pattern of crime influenced by urban geography. As evidenced

in Table 3, the anomalies reported for Peer Group 2 did have higher average indexes than Peer Group 1, which suggests this cluster is more likely to have outliers, indicative of unidentified patterns within the data. However, all indexes remain below the significance threshold of 1.

Table 3: Peer Group 2 Anomalies:

Contribution	Count	Average Index
Police District ID	2	0.068
Offense Code	2	0.568
Offense Type ID	2	0.328

The higher rate of anomalies in Peer Group 1 could suggest additional community level factors at play causing outlier cases of crime to occur within certain geographic areas. Similarly, the significantly lower number of outliers in Peer Group 2 suggests a higher likelihood that crime within this cluster is much more closely associated with specific geographic predictors with little deviation in identified patterns. However, because anomaly testing is sensitive to which measurements are within a dataset, altering the defaults prior to testing is not always an option. For example, police district identifications are still read as a continuous variable so the peer group profiles produce decimal places for those variables, leaving interpretation up to the researcher which can generate inherent bias in the results. From a methodological point of view, anomaly testing lacks the specification and parameter setting of more tailored clustering approaches and therefore cannot provide as accurate an insight into the data. Comparing the anomalous clusters to the more structured clustering models will help explain the resulting accuracy and predictive power of a more researcher driven modeling approach.

4.3 Two-Step Clustering: Predictor Importance for Marijuana Industry Specific Crime

As a result of the nominal dominated variable measurements with this dataset, a clustered analysis approach was chosen because most other model builders are variable measurement sensitive and not all the variables of interest would have been included. Cluster analysis groups sets of objects, or variables, based on the similarities of individual data points and how they relate to corresponding data points. Approaching marijuana legalization research from a clustering perspective has yet to be mentioned in current scholarly work and affords the opportunity to identify predictive patterns for the purpose of making stronger policy recommendations in the future.

Multiple two-step cluster analyses can be run based on the selected target variable to determine which combination of inputs has the highest predictive power. With marijuana industry related crime as the first target variable, a two-step cluster analysis was run to determine which of the 6 remaining inputs were most significant in determining marijuana industry related crime. Five clusters with an overall model silhouette quality of .06— "good" quality—were built. Model quality is based on completeness of the data used during the model runs and the predictor accuracy of the variables related to the target. As evidenced by Table 4, police districts and neighborhood identifiers were the most important predictors for marijuana related crime, while the actual criminal offense type field was the least important predictor. Cluster 1 was the largest cluster representing 26% of all reported crime cases from 2013-2018, with 100% of crime in that cluster occurring in police district 3, which encompasses the Denver metropolitan area. Although the offense type is the least important predictor, clusters 1, 5, 3, and 4 all report the most frequently occurring offense type to be burglary of businesses where excessive force was used, with cluster 2 reporting street level robbery as the most

frequently reported crime within police district 6. The two largest clusters, 1 and 5, are adjacent to one another geographically, with police districts 3 and 2 sharing jurisdictions throughout the Denver metro area. Cluster 2 demonstrates an interesting profile in that police district 6, a more rural area, is responsible for most street-level crime. While dispensaries are responsible for many city-based burglaries, the increase in rural marijuana cultivation licenses means properties growing the raw materials for marijuana sale are also a crime target.

Table 4: Marijuana Industry Related Crime Two-Step Cluster Analysis Breakdown

Predictor/ Input	Cluster 1 (355 cases)	Cluster 5 (306 cases)	Cluster 3 (260 cases)	Cluster 4 (251 cases)	Cluster 2 (199 cases)
Police District ID (most important)	District 3 (100%)	District 2 (100%)	District 1 (100%)	District 4 (99%)	District 6 (60%)
Neighbor-hood ID	Overland (25%)	Elyria-Swansea (40%)	Globeville (25%)	Valverde (19%)	Montbello (28%)
Precinct ID	Precinct 313 (41%)	Precinct 212 (41%)	Precinct 112 (32%)	Precinct 422 (30%)	Precinct 611 (21%)
Offense Type (least important)	Burglary-Business by force (56%)	Burglary-Business by force (50%)	Burglary-Business by force (45%)	Burglary-Business by force (51%)	Robbery-Street (17%)

Clusters are arranged in order from largest (1) to smallest (2) and Predictors are arranged in order from most to least important. The percentages listed represent how much of the cluster's crime is accounted for by that input. For instance, all of Cluster 1 reports crime in police district 3 but only 25% of the cluster's crime is reported in the Overland neighborhood.

4.4 Two-Step Clustering: Predictor Importance for All Crime Categories

The second cluster analysis targeted the offense type variable and looked at the predictor importance of police district, precinct, neighborhood, and offense category identifications as the model's inputs. Only 4 clusters were generated in this model and the overall quality was 0.4, 0.2 cohesion points lower than the first cluster analysis. It is important to note that the marijuana industry related crime variable was excluded as an

input in this model run because its category size was too large to be included as a predictor. However, the cluster breakdowns can be cross-referenced to the original dataset to determine which percentage of crime within the cluster's geographic area is associated with the marijuana industry.

Cluster 1 was the largest representing 31% of the overall model. As seen in Table 5, police districts 2 and 3 still represent the highest frequency areas for burglary related crime most frequently associated with marijuana industries, as confirmed by cross-referencing with the original dataset. This further supports the previous clustering model's results showing concentration in a largely urban area is a strong predictor for specific crimes related to the marijuana industry. All clusters represent close geographic proximity to legal dispensaries even in the absence of the marijuana industry variable as a predictor input. Compared to the more rural representations in the first model run with industry level predictors, this suggests a multi-level industry impact on crime based on the type of marijuana business most prevalent in a given geographic area.

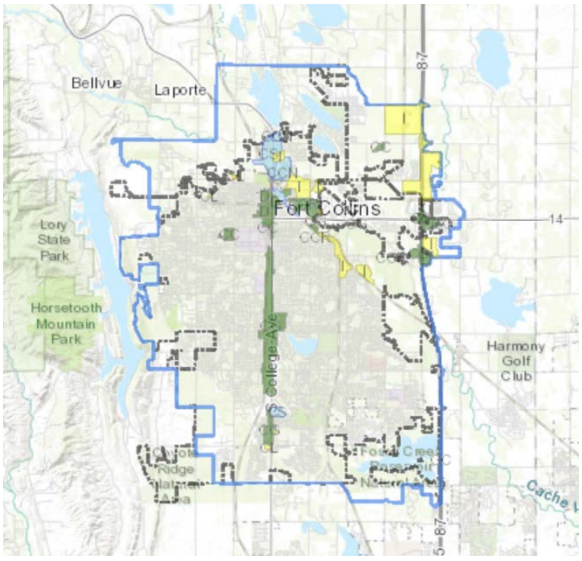
Table 5: Offense Type Two-Step Cluster Analysis Breakdown

Predictor/Input	Cluster 1 (208 cases)	Cluster 4 (169 cases)	Cluster 3 (161 cases)	Cluster 2 (136 cases)
Police District ID (most important)	District 2 (72%)	District 3 (100%)	District 4 (78%)	District 1 (100%)
Precinct ID	Precinct 212 (33%)	Precinct 313 (42%)	Precinct 412 (27%)	Precinct 112 (38%)
Neighborhood ID	Elyria-Swansea (33%)	Overland (28%)	Athmar-Park (16%)	Globeville (29%)
Offense Type (least important)	Burglary (49%)	Burglary (68%)	Burglary (60%)	Burglary (65%)

Clusters are arranged in order from largest (1) to smallest (2) and Predictors are arranged in order from most to least important. The percentages listed represent how much of the cluster's crime is accounted for by that input. For instance, 72% of Cluster 1 reports crime in police district 2 and 33% of that crime is occurring in the Elyria-Swansea neighborhood.

Geography as a predictive factor for how legalization will manifest within a community is a powerful visualization supportive of the dangers of policy change without strategic planning. Overlaying the above results with current economic development and zoning projects specific to the marijuana industry strengthens the argument that poorly formulated policy exploits geographic vulnerabilities. As evidenced in Map 1 below, Colorado began an active and rapid re-zoning project to increase state revenue from marijuana dispensaries and cultivation sites. Zoning regulations invited dispensaries to urban areas with denser populations and more economic potential while increasing use of rural areas to cultivate the raw materials needed for production.

Map 1: Zoning of Legal Marijuana Dispensaries



Map 1: The yellow shading represents businesses with an Optimal Premises Cultivation (OPC) and/or a Marijuana Infused Products (MIP) license; the green shading represents for sale centers (medical or recreational); and the light blue represents the overlap of OPCs, MPIs, and centers located in the same area

Source: Colorado Department of Public Safety, Business and Zoning Mapping

The long strip of green in the heart of the city are retail marijuana centers only whose locations are strategically situated along the College Avenue corridor. Given the research explaining the risk factors for adolescent and young adult use, this type of zoning regulation exploits known risk taking behaviors of younger populations and serves to institutionalize a low perception of harm associated with a chemically unregulated

substance. The unfortunate conclusions drawn from the cluster analyses coupled with the mapped zoning projects suggests that strategic planning was considered with legalization but for the purposes of economic development instead of community development. Secondary prevention and law enforcement initiatives were not implemented alongside Colorado's larger legalization policy. Therefore, the result was a weakening public safety apparatus faced with unfettered access to an unregulated and under-researched substance.

5. Conclusion

Marijuana crime clusters in a legal environment within population dense areas provides strong support for the hypothesis that marijuana legalization increases the concentration of availability and accessibility of the substance within certain areas and exploits criminal activity closest to marijuana industry locations. The results of anomaly testing demonstrated general pervasive patterns of crime relative to geographic proximity to available and legal marijuana throughout Colorado. Taking the anomaly testing further and conducting two-step clustering analyses, the results supported the initial patterns and further highlighted the specific urban centers within Denver's police districts 2 and 3 where marijuana industry related crime had the highest reporting rates. The results additionally indicated that legalization policy enacted in the absence of strategic prevention, education, and law enforcement initiatives exploits vulnerabilities for use and crime. Colorado's intensification of specific crimes proximal to legal dispensaries is suggestive of community level problems exacerbated by the legal presence of an otherwise unregulated substance. Without including support structures to accommodate inevitable individual and community level changes from legalization, the resulting policy lacks a necessary tailored and structured implementation process. An increase in

marijuana industry crime involving burglaries of businesses by force further suggests that the underlying risk factors for marijuana use and accessibility were not addressed prior to Colorado's policy change. A pattern of high frequency forceful theft indicates that individuals are unable to either afford or legally purchase marijuana regardless of policy. Therefore, the results presented herein posit that legalization is not a unilateral alleviation method for illegal use or possession, and contingency planning needs to parallel policy change that can adapt to the community level factors informing the demand side of marijuana use and sale throughout the state.

Although the clusters suggest geographic vulnerabilities for zoning of marijuana dispensaries in urban centers, these results lack a comparative context of crime rates across type categories over longer periods of time with controlled variables. Without understanding how crime rates within categories differ before and after a legalization policy is adopted, isolating the community factors impacted most during legalization is limited. Currently, there is a lack of datasets inclusive of a range of community level variables aimed at better understanding legalization policy from a grassroots level. The dataset used for this research did not account for crucial demographic differences within the target population, like socioeconomic status (SES) and education barriers that are known to inform substance use and crime patterns within communities. Current marijuana research has suggested a strong correlation between demographic information, like education and SES indicators, and risk-taking behaviors associated with substance use. However, there remains a woeful dearth of comparative analysis on demographic, use, and crime correlations as they relate to the eventual impacts of marijuana legalization policies.

Future research should strive to improve the current data pool by collecting pre- and post- legalization data for states still determining their policy direction. Although the Colorado case study highlights the dangers of tunnel vision policy development unable to adequately integrate community vulnerabilities, it will likely not be synonymous with legalization effects across the country. Governing systems need to better incorporate a wholistic approach to community readiness for policy change and implement strategic initiatives prepared to respond to anticipated effects, whether positive or negative. Understanding the socioeconomic, demographic, and education breakdown of a community and how those divisions will either be supported or exploited by legalization informs successful and sustainable policy implementation. Collecting baseline data that can address these factors allows for that same data collected in a post-legalization community to be compared and analyzed based solely on policy change, holding variables like age, SES, and education constant.

The overall results from this paper's analysis provide strong evidence for the need for states to incorporate strategic planning prior to legalization policies. Needs assessments should be conducted to understand the demographics of the areas, the current drug landscape, and the existent gaps in public safety resources and support. The Colorado case study is an example of the weaknesses in enacting policy without first understanding the demographic and drug landscape of the communities to be affected by legalization. Supporting the supply side through legalization without understanding how and why the demand side exists undermines the dangers of substance use more broadly and limits the role strategic prevention and education can have in a nation plagued by addiction. There is great potential for hindsight lessons to better inform and structure

future policy replications to help avoid making the same mistakes. Because when the smoke clears but the mirrors remain, a changed perspective still leaves the same reflection no matter which way one turns.

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AWARDS

Phi Beta Kapa Society Induction **2014**

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Director of Outreach and Grants

Developed office outreach plan and managed district-wide grant research and liaison work for municipal projects

Council on Addiction Prevention and Education of Dutchess County, NY **2014**

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Organized and ran local community coalition focused on reducing youth substance use in Southern Dutchess County, NY, and was responsible for facilitating education and informational events quarterly

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Born and raised in Dutchess County, New York, Brynna is a 28-year-old young professional pursuing a career in intelligence analysis with the federal government. Currently working for the U.S. House of Representatives for her local Congressman, Brynna hopes to expand her government career to include more analytical based work. With an interest in the linguistic and cultural nuances inform political and international relations, she hopes to put her analytic and language skills to use in a counterintelligence capacity to contribute to national security priorities.